CLAIMS

1. A microvalve for providing flow regulation suitable for use in a microsystem comprising;

a first substrate layer defining a first plane;

a second layer disposed over the first substrate layer cooperating with the first substrate layer to form a flow duct through which the flow traverses thereby defining a direction of main flow;

an obstruction element defined by the second layer for obstructing the flow, said obstruction element being displaceable in a second plane substantially perpendicular to the direction of main flow and out of plane with respect to the first substrate layer; and

actuator means operative on the obstruction element for controllably displacing the obstruction element to regulate the flow.

2. The microvalve according to claim 1 wherein, the microvalve is a knife gate microvalve whereby the obstruction element is a gate displaceable in the plane substantially perpendicular to the main flow direction for obstructing the flow, and wherein the gate is pivotally attached to the second layer via a member to enable displacement of the gate in a plane that is out of plane with respect to the first substrate layer to obstruct the flow.

3. The microvalve according to any one of claims 1-2 wherein, the external actuator means is attached to the obstruction element operative for controllably displacing the obstruction element to regulate the flow.

4. The microvalve according to any one of the above claims wherein, the actuator means is a thermal bimorph actuator comprising materials with different thermal expansion coefficients such as aluminum bonded together with the

material from the second layer, wherein a controllable temperature change causes the bimorph actuator to bend due to the difference in thermal coefficients of expansion between the materials.

5. The microvalve according to any one of claim 1-4 wherein the gate is pivotally attached to the second layer by at least two members comprising thermal bimorph actuators, and wherein the selective actuation of the members displace the gate in opposite directions when actuated such that the microvalve can be actively opened or closed by heating up the actuator means.

6. The microvalve according to any one of claims 1-3 wherein, the microvalves are actuated using piezoelectric actuation means.

7. The microvalve according to any one of claims 1-3 wherein, the microvalves are actuated using magnetic means.

8. The microvalve according to any one of claims 1-3 wherein, the microvalves are actuated using electrostatic means.

9. The microvalve according to any one of claims 1-3 wherein, the microvalves are actuated using thermal actuation means such as monomorph expansion, shape memory, or thermopneumatic means.

10. The microvalve according to any one of the above claims wherein, the obstruction element is displaced to obstruct the flow in a frictionless "free-hanging" manner in order to avoid tribological effects during operation.

11. The microvalve according to claim 10 wherein, the "free-hanging" obstruction element, when in a closed position, is laterally moved a small

distance in a direction substantially parallel to the direction of the direction of the flow against a jam formed from the second layer to reduce or block off any leakage flow.

12. The microvalve according to any one of the above claims wherein, the main flow is redirected at a point sufficiently far from the obstruction element and actuator means so that any pressure buildup from the main flow will not create forces that will counteract the operation of the obstruction element.

13. The microvalve according to any one of the above claims wherein, said second layer mainly comprises silicon material into which the microvalve structures and features are machined into a silicon wafer using bulk micromachining or surface micromachining.

14. The microvalve according to claim 13 wherein, the microvalve structures are microfabricated using Deep Reactive Ion Etching (DRIE).

15. The microvalve according to claim 12 wherein, the said second layer mainly consists of a polymer and which is fabricated using plastic replication.

16. The microvalve according to any one of the above claims wherein, the cross-sectional area of the flow duct is perpendicular to the plane of the substrate allowing the footprint area (FPA) of the device to be independent from the cross-sectional area of the flow.

17. The microvalve according to claim 16 wherein, the ratio between the flow duct length and the hydraulic diameter of the flow duct is at least less than 10, such that the footprint area (FPA) is minimized.

18. A microsystem for providing electro-pneumatic pressure control, wherein the microsystem having at least three pneumatic ports including a supply port, a work port and a vent port, and wherein the three ports are coupled repectively to a supply pressure (P_{supply}), a work pressure (P_{work}), and a vent pressure (P_{vent}), said microsystem comprising;

a first microvalve pneumatically coupled to the supply port and the work port for regulating the flow between supply port and the work port;

a second microvalve pneumatically coupled to the work port and the vent port for regulating the flow between the work port and the vent port; and

control signal means electrically coupled to the microvalves to control the pneumatic flow within the microvalves by actuating the microvalves.

19. A microsystem according to claim 18 wherein, the microsystem comprises the microvalves of claims 1-17.

20. A microsystem according to claim 18 wherein, the microvalves are actuated using piezoelectric actuation means.

21. A microsystem according to claim 18 wherein, the microvalves are actuated using magnetic means.

22. A microsystem according to claim 18 wherein, the microvalves are actuated using electrostatic means.

23. A microsystem according to any one of claims 18-22 wherein, said microvalves are microfabricated and manufactured into a pneumatically sealed package connectable to external flow ducts.

24. A method of operating a microvalve to provide flow regulation of a fluid comprising a first substrate layer, a second layer disposed over the first substrate layer cooperating with the first substrate layer to form a channel through which a flow traverses and defining a direction of flow, an obstruction element defined by the second layer for obstructing the flow, and actuator means attached to the obstruction element for displacing the obstruction element, the method comprising the step of displacing the obstruction element along a plane substantially perpendicular to the direction of the flow and out of plane with respect to the first substrate layer.

25. The method according to claim 24 wherein, the displacement of the obstruction element is produced by a thermal actuation means, magnetic means, piezoelectric means or electrostatic means.

26. The method according to claim 24 wherein, the obstruction element can be actuated and displaced in opposite directions in response to a control signal such that the microvalve can be actively opened or closed by heating up the actuator means.